

BALTIMORE INNER HARBOR, PIER 6
South side of Pratt Street between
Concord St. and the Jones Falls outlet
Baltimore City
Maryland

HAER No. MD-86-B

HAER
MD,
4-BALT,
225B-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

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MD
4-BALT,
225B-

Baltimore Inner Harbor, Pier 6

HAER No. MD-86-B

Location: South of Pratt Street between Concord Street and the Jones Falls Outlet
Baltimore, Maryland

UTM: 18.362420.4349400 361604.4349298

Quad: Baltimore East, Maryland

Dates of Construction: 1908-1910; 1984

Engineer: 1908-1910 - Oscar F. Lackey, Chief Engineer, Baltimore Harbor
Board
1984 - Whitman, Requardt and Associates

Present Owner: City of Baltimore

Present Occupants and Uses: Surface Parking
Concert Pavilion (Performing Arts)
Office Structure (vacant)

Significance: Designed by Oscar F. Lackey and constructed in 1908-1910, the bulkheads on Piers 4, 5, and 6 in the Baltimore Inner Harbor were among the first reinforced concrete structures erected in seawater in the United States. These and other early concrete piers in the U.S. pioneered the acceptance of reinforced concrete in American harbors. The solid piers, consisting of filled reinforced concrete bulkheads, played a significant role in the evolution from timber pile to reinforced concrete for seawater construction.

Project Information: Betty Bird, 2025 Eye Street, N.W., Suite 801, Washington, D.C. prepared documentation under contract to the Christopher Columbus Center Development, Inc., from March 1992 to March 1993. The Christopher Columbus Center, an underwater archeology and marine research and education center, will construct a facility on Piers 5 and 6 that will require reinforcement of deteriorated concrete bulkheads on Piers 4, 5, and 6. Reinforcement will be constructed in front of existing material, obscuring the original concrete cylinders and sheet piles. This documentation was completed pursuant to 36 CFR 800 to mitigate the adverse effects of this undertaking.

DESCRIPTIVE INFORMATION

Pier 6 is a solid pier consisting of back-filled concrete bulkheads. The pier extends south from East Pratt Street into the Baltimore Inner Harbor between Concord Street and the Jones Falls outlet. (Jones Falls empties into the harbor immediately east of Pier 6.) The Inner Harbor is located on the Northwest Branch of the Patapsco River, which empties into the Chesapeake Bay.

Pier 6 was part of a 1904-1910 harbor improvement that originally consisted of 6 trapezoidal piers extending south into the Inner Harbor between Light Street and Jones Falls. These piers were constructed on the site of similar solid piers that had been thickly settled prior to the Baltimore Fire of 1904. As designed, Pier 6 was originally 205 ft. wide at its head, 1400 ft. long on the west and 1542 ft. long on the east. While its basic structural system was the same as Piers 4 and 5, Pier 6 incorporated several features that distinguished it from other Inner Harbor piers. The concrete bulkheads on the east side of Pier 6 facing the Jones Falls outlet were faced with granite from the former piers rather than reinforced concrete. Moreover, the western side of Pier 6 consisted of projecting slips that created a sawtooth edge in plan. Diagonal projections formed 20 ft. wide slips, each slip between 200 and 250 ft. long.

The original construction of the piers is depicted in engineering drawings. The following description appeared in 1909 in *The Engineer*, a British publication:

The face structures consist of series of steel cylinders, filled with concrete, connected by reinforced concrete sheet piling, and the superstructures are of reinforced concrete or masonry. The cylinders are 10 ft. in diameter, and built of 3/8 in. steel plate, stiffened by 3 in. by 3 in. by 3/8 inch angles. They are sunk to a depth of 27 ft. below low water and spaced 25 ft. centres. . . .

In the typical section the floor is carried by two 15 in. -- 45 lb. per foot -- steel channels on the face of the cylinder, and a 4 in. thick reinforced concrete wall in the rear, the wall resting directly on the top of the sheet piling. The latter is of reinforced concrete, gauged in the proportions of 1 cement, 2 sand, and 4 crushed stone or gravel. The piles are 18 in. wide by 12 in. thick, with four 3/4 in. steel bars in tension and four 3/8 in. square bars in compression. The longitudinal reinforcement is connected by 5/16 in. round steel hoops placed 18 in. apart. On the water side the reinforcement is covered by 2 in. thickness of concrete. The outward thrust of the sheet piling at the top is taken by a steel lattice girder, embedded in concrete, placed at a distance of 4 ft. to 5 ft. behind the face line of the pier. The girder, which is 2 ft. 6 in. deep horizontally, consists of four 6 in. by 6 in. by 7/8 in. angles double braced with 3 in. by 1/2 in. flat bars spaced 14 in. centres. The cylinders are tied back to anchor beams and piles by means of eight 1-1/8 in. square steel bars to each cylinder, or 25 ft. apart centre to centre of tie clusters. The tie bars are embedded in concrete measuring 18 in. by 10 in. in section. The anchor beam is 28 ft. back from the face line of the pier, and consists of concrete 3 ft. deep and 15 in. thick, reinforced by eight

1-1/4 in. square bars. The anchor beam rests on and is tied to two 15 in. diameter reinforced concrete piles abreast of each cylinder.

In the Jones' Falls walls . . . a reinforced concrete beam is substituted for the lattice girder. This beam is 2 ft. 2 in. by 2 ft. 6 in. with six 1 in. square bars to take the lateral thrust, and five 7/8 in. square bars to sustain the vertical load. The concrete mixture is the same as in the sheet piling. On top of the reinforced beam a rubble masonry wall is constructed.¹

Because Pier 6 was designed as a pier for stone, lumber, and other construction material, few structures were built on the pier. Historic photographs show only stacks of lumber on Pier 6. The 1951 Sanborn Map shows two small structures at the northern end of the pier; these structures were probably burned in the February 1968 fire that destroyed virtually all of the buildings on Piers 5 and 6.

The bulkheads are presently in deteriorated condition. Several engineering studies conducted over the past 20 years have documented the condition of this resource. A 1973 feasibility study by Whitman, Requardt and Associates assessed the condition of Piers 4, 5, and 6. Whitman Requardt found deterioration that was particularly severe toward the southern ends of the pier, which had been subjected to the greatest turbulence. Steel jackets encasing the cylinders had eroded and cylinders were disintegrating. The top portions of many of the cylinders were missing and remaining cylinders had holes. The beam at the face of the pier was damaged in several places. Concrete sheet piling was in "poor condition" and had shifted in several locations creating voids behind the sheeting. The timber fender system, which had been continually altered over the years, was still present, in good repair only in areas of use. In describing the condition of Pier 4, which also prevailed in Piers 5 and 6, Whitman, Requardt wrote,

In general the concrete used for the beams, girders, and cylinders is of very poor quality. Pieces can be easily removed or chipped away. Examination of such pieces reveals that there was insufficient cement paste to completely fill the voids in the aggregate. In addition such pieces can be easily crumbled by hand.²

Similar conditions were found on Pier 6. The facing beam on the west side of Pier 6 was in disrepair with concrete broken and steel reinforcement exposed. Steel casings for the cylinders had rusted away and concrete had spalled. Settlement and voids were evident behind the sheeting and the timber fender system on the west side of the pier was virtually gone. On the east side of the pier, the stone bulkhead was in good condition.³

¹"New Harbour Works at Baltimore," *The Engineer*, January 29, 1909, pp. 105-107.

²Whitman, Requardt and Associates, "Engineering Feasibility Report: Inner Harbor East," p. I-3.

³*Ibid.*, pp. I-3 - I-5.

The most extensive changes to the pier took place in 1984 when the northern 2/3 of Piers 5 and 6 were joined to form a parking area.⁴ The infill joined Piers 5 and 6 into a single U-shaped entity, destroying both the distinctive sawtooth configuration of the western edge of Pier 6 and the integrity of Pier 6 as an individual pier. Fill was added to the tip of Pier 6 and a stressed tent music pavilion was erected over the fill. The remaining surface of the pier was paved for parking and parking entry gates were constructed. In 1987 a bridge was constructed across the Jones Falls outlet linking Pier 6 with Fells Point at Eastern Avenue. This construction altered the bulkheads in the immediate vicinity of the bridge.⁵ Original bulkheads remain on the east side of the pier and the southern 1/3 of the west side of the pier.

The most recent study of Pier 6 conducted by M.G. McLaren, P.C. in September 1990 found that the granite bulkhead was in "fair" condition with the tidal zone exhibiting the most damage. Steel jackets encasing the concrete cylinders were missing. The top 5 ft. of the concrete was exposed and the concrete had spalled from 1" to 6" within the tidal zone. Reinforcing steel was exposed on over 20% of the beam, which was spalled along 90% of its length. The concrete sheeting exhibited corner spalls and gaps at the mud line and between the closure sheet and the concrete cylinder. Fill had eroded behind the sheeting. The remains of the timber fender system were visible, but the piles had deteriorated below the water surface. The granite block retaining wall was in good condition with the exception of loose or missing capstones.⁶

The same study found that the concrete bulkheads on the south and west sides of Pier 6 were severely deteriorated or had failed. The worst conditions were found at the southern 150 ft of the west side where the bulkhead had collapsed. The concrete cylinders were missing their steel jackets and were disintegrating, with their top portions either missing or having holes. Aggregate could be removed by hand. The reinforcing steel within the facing beam, which was broken along most of its length, was exposed. Sheeting behind the beams was displaced. Grout used to repair the cylinders on the west side had lost structural integrity. There were gaps between the sheeting bays and between the sheeting and the cylinders. Fill was leaking from between the gaps, which in some cases exceeded 8" in width. The subsidence of fill had created two severe voids on Pier 6. Stubs of the fender system were still visible at or below the water line.⁷ Nevertheless, for the most part the basic structural system of Pier 6 remains despite isolated failures and serious deterioration.

HISTORICAL INFORMATION

Designed by Oscar F. Lackey and constructed in 1908-1910, the bulkheads on Piers 4, 5, and 6 in the Baltimore Inner Harbor were among the first reinforced concrete structures erected in seawater in the United States. These and other early concrete piers in the U.S. pioneered the acceptance of reinforced concrete in American harbors. The solid piers, consisting of filled reinforced concrete bulkheads,

⁴Rummel, Klepper & Kahl, "Engineering Feasibility Analysis," p. ii.

⁵*Ibid.*, p. III-2.

⁶M.G. McLaren, P.C. "Pier 6 Bulkhead Inspection," pp. 2-3.

⁷*Ibid.*, pp. 4-5.

played a significant role in the evolution from timber pile to reinforced concrete for seawater construction.

The piers in the Inner Harbor were built on the site of earlier piers that the devastating fire of February 1904 had reduced to rubble. (Please see Baltimore Inner Harbor, HAER No. MD-86 for information about rebuilding the Inner Harbor.) While construction of Piers 1, 2, and 3 had employed traditional methods and materials, the bulkheads on Piers 4, 5, and 6 were of reinforced concrete construction. The use of reinforced concrete for seawater construction was highly controversial as late as 1915. Oscar F. Lackey (1874-1928) is credited with being among the first in the United States to employ this method. His obituary stated that, "he was one of the first, if not the first, engineer to utilize reinforced concrete piles in pier construction."⁸ Biographical information about Lackey may be found in Baltimore Inner Harbor, HAER No. MD-86. For a full discussion of the use of reinforced concrete technology during this period, please see Baltimore Inner Harbor, Pier 5 (HAER No. MD-86-A).

Because of the controversy surrounding the use of concrete in seawater and the lack of experience with it in the United States, Piers 4, 5, and 6 played an important role in demonstrating that the material could be used with success and in providing cost data that helped establish an economic rationale for using concrete in other situations. The 1913 Annual Report of the Harbor Board recalled that "plans for the first concrete piers ever constructed in this country, after a hard fight on the part of the Harbor Board, were approved."⁹ In their 1907 Annual Report, the Harbor Board cited the following reasons for using concrete for Piers 4, 5, and 6:

the Harbor Board has adopted the use of concrete and steel for construction of Piers 4, 5 and 6 in preference to that of pile and timber for several reasons:

- 1st. It is cheaper
- 2nd It is more durable, stronger and better suited to the conditions of the barbor, and it is permanent.
- 3rd The work can be carried on without any great interference by tides, which has been the main cause of delay in the construction of Piers 1, 2 and 3.
- 4th The piers present a better appearance.
- 5th The cost of maintenance is very materially decreased.
- 6th Provision is made, for those desiring, for the erection of sheds either of steel or of timber.
- 7th We feel that as the water of the harbor becomes less polluted, due to the diversion of sewerage now emptying into same, such sewerage being taken up by the new sewerage system, that the "teredo," a most destructive worm, will make its appearance. This has happened in other ports under similar conditions. This worm, which eats its way into the timbers, chiefly between the M.L. and M.H. water lines, can be found as far up as Sparrows Point. At Annapolis all piles are protected by concrete or otherwise against the "teredo," which doubles the cost of construction.

⁸Whitman, p. 1863.

⁹Harbor Board Report for 1913, p. 68.

For this reason, if for no other, this Board does not think it advisable to put out a great amount of money for the construction of piers, which in all likelihood will in the course of a few years require a large additional expenditure to make them safe.¹⁰

For a full discussion of the teredo worm, please see Baltimore Inner Harbor, Pier 5 (HAER No. MD-86-A).

Oscar F. Lackey and engineers at the Harbor Board designed Piers 4, 5, and 6. Like other early concrete docks in the U.S., the basic form of the Baltimore piers appears to be derived from the Navy Department's 1902 design for docks in Manila.¹¹ During 1908, the Harbor Board produced 102 plans, 76 tracings, and 478 blue prints, "principally ... details of the pier construction."¹² The Board opened bids in 1908 and awarded the construction contract to Sanford and Brooks of Baltimore.¹³ Sanford and Brooks subcontracted work on the steel caissons to the Maryland Steel Company, which in turn subcontracted with the Snare & Triest Company and Bernard Rolf of New York. Concrete work was subcontracted to Raymond Concrete Pile Company, also of New York. Penniman and Browne, Chemists tested cement; Stulen Company of Harrisburg tested the steel.¹⁴ The City Engineer's Department, compensated by the Harbor Board, paved the piers. Pier 6, designed specifically as a lumber pier was paved with vitrified brick block on a 6 in. concrete base with concrete filler.¹⁵ Pier 6 cost \$1,477,220.06, \$951,363.76 of which was for land. Each pier had a load limit of 1000 lbs. per sq. ft.¹⁶

Existing conditions on Pier 4 resulted in a change from the original design of the piers in the bidding specifications. Modifications to accommodate the United Railways and Electric Company Power Plant, which had survived the 1904 fire, proved more efficient and less costly than the original design. For further information on the design changes and a detailed description of the construction of the bulkheads, please see Baltimore Inner Harbor: Pier 5 (HAER No. MD-86-A). Addition information on the Power Plant may be found in Baltimore Inner Harbor: Pier 4 (HAER No. MD-86-B).

Pier 6 posed unique constraints because of its location at Jones Falls on the east. The Harbor Board did not believe that the water depth at Jones Falls could be maintained at 24 ft. so they designated it for the use of lumber vessels, which had a shallow draft.¹⁷ Historic photographs through the 1940s depict the pier stacked with lumber. Unlike the other piers in the Inner Harbor, Pier 6 was not developed with wharves or other structures.

¹⁰Harbor Board Report for 1907, pp. 16-17.

¹¹Taft, p. 1077.

¹²Harbor Board Report for 1908, p. 30.

¹³Harbor Board Report for 1908, pp. 19 and 20.

¹⁴Harbor Board Report for 1908, p. 24.

¹⁵Harbor Board Report for 1909, pp. 14-16.

¹⁶Harbor Board of Baltimore, *Survey of the Port of Baltimore*, Vol. 1, pp. 24-27.

¹⁷Harbor Board Report for 1908, pp. 22-23.

SOURCES OF INFORMATION

For general sources and additional sources of information on Piers 4, 5, and 6, please see Baltimore Inner Harbor (HAER No. MD-86) and Baltimore Inner Harbor, Pier 5 (HAER No. MD-86-A).

A. Engineering Drawings:

Working drawings: Collection of Peter Van de Castle (private collection to be donated to the Baltimore Museum of Industry)

Plans, site plans, schematic drawings, and structural diagrams: *Reports of the Harbor Board*, 1904-1914 (Enoch Pratt Free Library)

Structural diagrams. "New Harbour Works at Baltimore," in *The Engineer* (Jan. 29, 1909), pp. 104-106. (Library of Congress)

As built drawings. Harbor Board of Baltimore. *Survey of the Port of Baltimore*, Volume 1, 1920.

B. Historic Views:

Please see Baltimore Inner Harbor (HAER No. MD-86) for information on general views of the Inner Harbor, including Pier 6. *The Reports of the Harbor Board* for this period also contain numerous photos of the piers and the piers under construction. Please see Baltimore Inner Harbor, Pier 5 (HAER No. MD-86-A) for additional detail on *The Reports of the Harbor Board*.

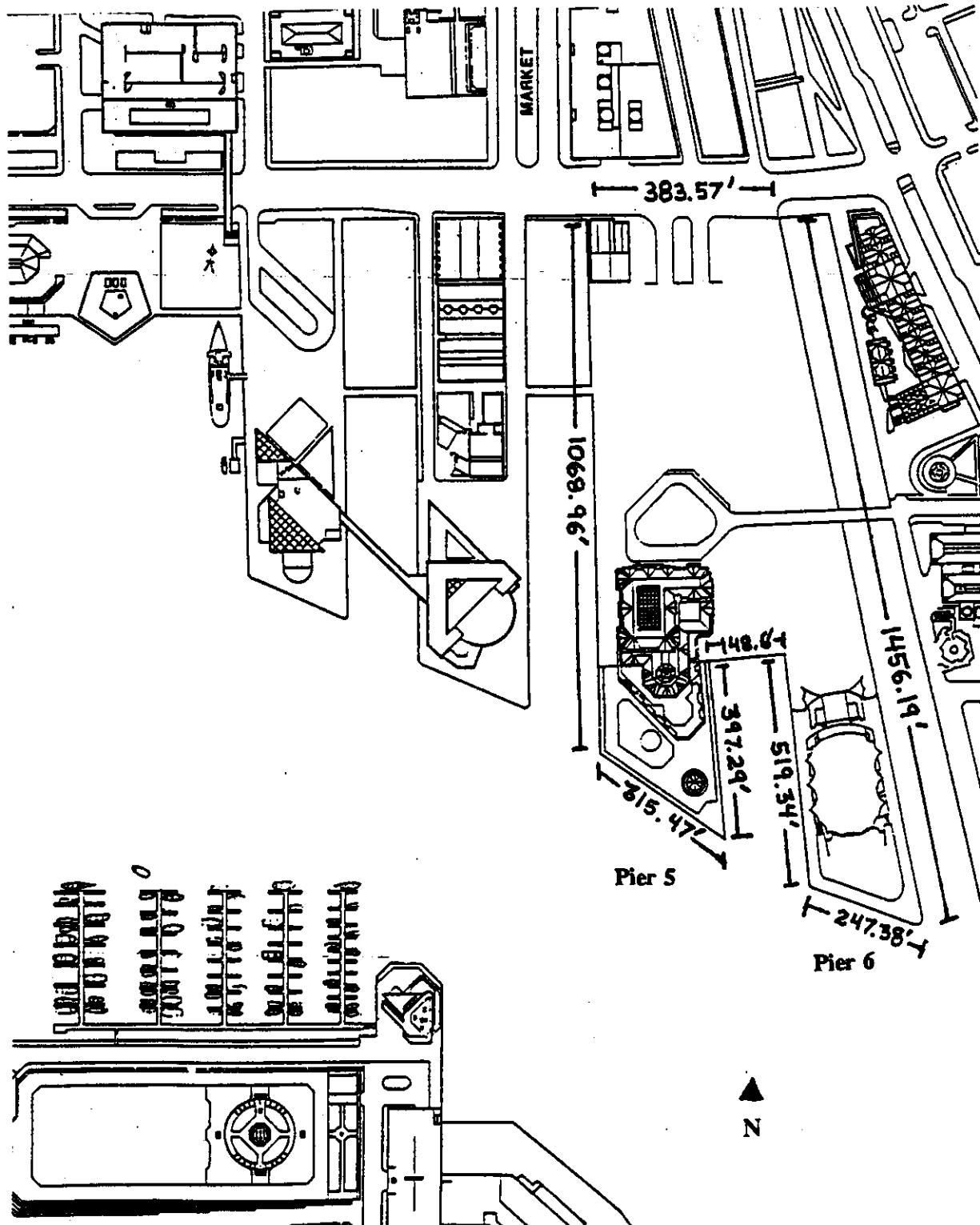
C. Bibliography:

A full bibliography pertaining to the construction of reinforced concrete piers in seawater and references to reports treating the present condition of Piers 4, 5, and 6 may be found in Baltimore Inner Harbor, Pier 5 (HAER No. MD-86-A)

D. Likely sources not yet investigated:

This investigation was focused on the reinforced concrete technology for the bulkheads on Piers 4, 5, and 6. Less attention was devoted to the history of the use of Pier 6 and a detailed evolution of the harbor. This material can be found in *Reports of the Harbor Board*, Enoch Pratt vertical files, and numerous published histories of the harbor.

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SITE PLAN
Source: Gannett Fleming, Inc.

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